ABSTRACT

Traditional rice varieties have come into existence over a series of evolution and adaptation processes in a particular agro-environment and agricultural practices. Necessities have arisen to re-evaluate these rice varieties for their adaptabilities in the local agro-climatic zone aiming at developing strategies for improving abiotic stress tolerance. This thesis reports agro-morphological and grain quality characterization of 13 traditional rice varieties, with emphasis on phyto-protectant mediated salinity tolerance in one of these varieties. Evaluation of agro-morphological traits revealed that the studied varieties were late-maturing with low-yield potential. Measurement of physical and cooking grain quality traits and subsequent clustering resulted in the grouping of varieties based on the size and shape of the grain. Size and shape affect physical appearance, as well as milling quality of grain. However, exploring variability in the metabolite and mineral composition of grains of traditional rice varieties with varying grain size and shape will add another dimension to the visual appeal. Therefore, a representative variety from each cluster was selected for GC-MS and ICP-MS based analysis. For further validation, PLS-DA was performed, and a clear separation of varieties based on their metabolite and elemental profile was observed. This indicates that unique metabolite and elemental profiles exist for traditional rice varieties with different grain morphology. 'Chakhao' black rice, a traditional rice variety of Manipur, India, is renowned for its scent and color of the grain. Among different phytoprotectants tested, supplementation of Mn resulted in improved growth and photosynthesis in black rice seedlings under salinity stress. To examine if Mn-mediated salinity tolerance is a result of the altered metabolic response, GC-MS based metabolite profiling was done. PCA of the metabolite profiling data revealed a treatment-based modulation of metabolism in rice seedlings. Seedlings supplemented with Mn alone have accumulated high levels of TCA cycle intermediates and amino acids alanine and glycine, all of which were reduced upon salinity stress. This reduction was accompanied by a marginal increase in the levels of other amino acids and a substantial increase in sugar levels in seedlings subjected to salinity stress. However, when seedlings were supplemented with Mn under salinity, a significant increase in the levels of amino acids including GABA, and sugar alcohols was observed. In addition, activities of enzymes involved in the TCA cycle were determined. Activities of pyruvate dehydrogenase (PDH) and isocitrate dehydrogenase (ICDH), enzymes upstream to α-ketoglutarate, did not reflect the trend followed by TCA cycle intermediates. But, activities of succinate dehydrogenase and malate dehydrogenase, enzymes downstream to α-ketoglutarate, showed a trend similar to that of TCA cycle intermediates. Increased levels of TCA cycle intermediates and TCA cycle enzyme activities in seedlings supplemented with Mn alone suggest a very high TCA cycle activity supporting the increased growth. Reduction in alanine and glycine levels with a simultaneous increase in the levels of other amino acids suggest a photorespiratory-mediated amino acid synthesis in seedlings under salinity stress. Comparatively higher activities of PDH and ICDH, lower levels of TCA cycle intermediates, and increased levels of GABA and other amino acids suggest that

GABA shunt operates in seedlings supplemented with Mn under salinity stress. So, it can be concluded that Mn-mediated salinity tolerance in black rice seedlings is due to the modulation of metabolic responses to salinity stress.

Keywords: Traditional rice varieties, grain size, grain shape, salinity tolerance, phytoprotectants, metabolic reprogramming